



Sonoma Technology, Inc.

**SOUTHERN CALIFORNIA AIR QUALITY STUDY (SCAQS)
PROGRAM PLAN**

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from the California Air Resources Board (ARB) and other
sponsors, participants, and members of the technical
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ABSTRACT

This program plan outlines the measurement and management approach and reviews the technical background for the Southern California Air Quality Study (SCAQS). SCAQS is a multi-year, integrated, cooperative study which is funded by many different government agencies, industry groups, and individual corporate sponsors. This plan has been prepared with the input of the sponsors, participants, and potential users of the study data and represents a composite of their ideas.

The overall goal of SCAQS is to develop a comprehensive and properly archived air quality and meteorological data base for the South Coast Air Basin that can be used to test, evaluate, and improve elements of air quality simulation models for oxidants, PM-10, fine particles, toxic air contaminants, and acidic species. In addition, SCAQS will provide a data base which can be used to address specific technical questions regarding the emission, transport, transformation, and deposition of pollutants.

The study is planned to take place in 1987 during six weeks in early summer and four weeks in late fall. Extensive routine measurements and special studies will take place on 18 days during the study. Most of the monitoring will take place at existing air quality monitoring sites. Airborne, meteorological, and tracer measurements are planned at additional locations.

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1. INTRODUCTION

1.1 BACKGROUND AND ISSUES

In recent years in California, the mix and spatial distribution of pollutant emissions have changed substantially, and several new classes of pollutants have gained the public's attention. In the next few years, many difficult regulatory issues relating to these changes will confront the California Air Resources Board (ARB), the Environmental Protection Agency (EPA), and the South Coast Air Quality Management District (SCAQMD). Resolution of these issues and development of effective control strategies to ameliorate California's air quality problems will require a better understanding of the relationships among the sources, receptors, and effects of the pollutants in question. This understanding can only be developed through measurement, data analysis, and modeling in an iterative fashion. Design and evaluation of alternative control strategies must be done using models which embody our best understanding of the above relationships.

This program plan outlines the first steps in a measurement, analysis, and modeling strategy which can ultimately provide the regulatory agencies with tools necessary to make effective decisions. This study, the Southern California Air Quality Study (SCAQS), addresses the following issues: ozone (O_3), NO_2 and the roles of nitrogen oxides (NO_x), PM-10, fine particles, visibility, toxic air contaminants, and atmospheric acidity. The first five issues are addressed in depth, and adequate information should result from this project for the development and testing of descriptive and prognostic models. Understanding of the latter two issues will be greatly improved by this study, but this study alone will not necessarily provide the information required to develop and test prognostic models.

Although similar problems are faced by most California air basins, the focus of this study will be the South Coast Air Basin (SOCAB) since that is where the problems are most severe. Also, the SOCAB is one of the most well documented and intensively researched airsheds in the world.

Since the scope of the study is beyond the resources of the ARB alone, and since the results of the study could affect the actions of both government and industry, SCAQS has been designed as a cooperative project. Coordinated sponsorship by both government and industry should help assure adequate funding to meet the goals of the study. In addition, development of a protocol which is satisfactory to the parties affected by the results should minimize conflict about technical issues during the regulatory process.

SCAQS is designed to meet the goals and objectives agreed upon by the ARB and other potential sponsors. This program plan is the result of an open planning process which entailed extensive consultation with the modeling and measurement communities. The resulting design is an attempt to satisfy the needs expressed by the technical community to meet the stated objectives. The scope is quite large, and there obviously will be additional changes as the study evolves. The earlier version of this document (Blumenthal et al., 1986) was used as a starting point from which the final study design has been constructed. Feedback from potential sponsoring agencies and data users regarding their relative priorities and levels of resources has been used to refine the design. Lists including most of the people and organizations who

have been involved in the planning process to date are included in Appendix A.

SCAQS data will be used to test and evaluate models which predict or describe the ambient distribution of pollutants. These models, in turn, will be used to develop and assess control strategies. The relationship between the SCAQS measurements and their ultimate use in developing control strategies is shown schematically in Figure 1-1. The primary focus of SCAQS is to provide measurements which relate source emissions to ambient pollutant spatial and temporal distributions. SCAQS will also include some source and effects-related measurements and a data analysis component.

The development and use of models can be a controversial subject because the model results have direct implications in terms of emissions controls. To minimize controversy and to expedite the measurements, SCAQS is designed to focus on measurements and data analysis but not directly to include modeling efforts. This modeling will be performed by the sponsors at a later date. However, since SCAQS must serve the needs of the modelers, extensive input has been solicited from the modeling community during the SCAQS design phase. A quantitative analysis of air quality modeling needs for input and testing data was undertaken as part of the SCAQS planning process (Seinfeld et al., 1986), and the SCAQS measurements presented here are consistent with that analysis.

1.2 STUDY GOALS

The overall goals of the study are:

1. to develop a comprehensive and properly archived air quality and meteorological data base for the South Coast Air Basin which can be used to test, evaluate, and improve elements of air quality simulation models for oxidants, NO_2 , PM_{10} , fine particles, visibility, toxic air contaminants, and acidic species. The data base should be adequate:
 - to test models proposed for the design of attainment strategies for PM_{10} , ozone, and NO_2 ; and
 - to clarify the hydrocarbon/ NO_x / O_3 relationships so that ozone prediction models can be improved and new strategies to meet federal "reasonable efforts" requirements can be developed and tested;
2. to evaluate measurement methods for PM_{10} , fine particles, acidic species, and important nitrogen and carbon species; and
3. to enhance our understanding of the relationships between emissions and the spatial and temporal distributions of pollutants so that air quality simulation models and, ultimately, air quality management strategies can be improved.

The data obtained by meeting these goals should be of utility in the development and testing of air quality models of known accuracy, precision, and validity which can be used to design and evaluate the effect of proposed attainment strategies for O_3 , NO_x , PM_{10} , and selected toxic air contaminants.

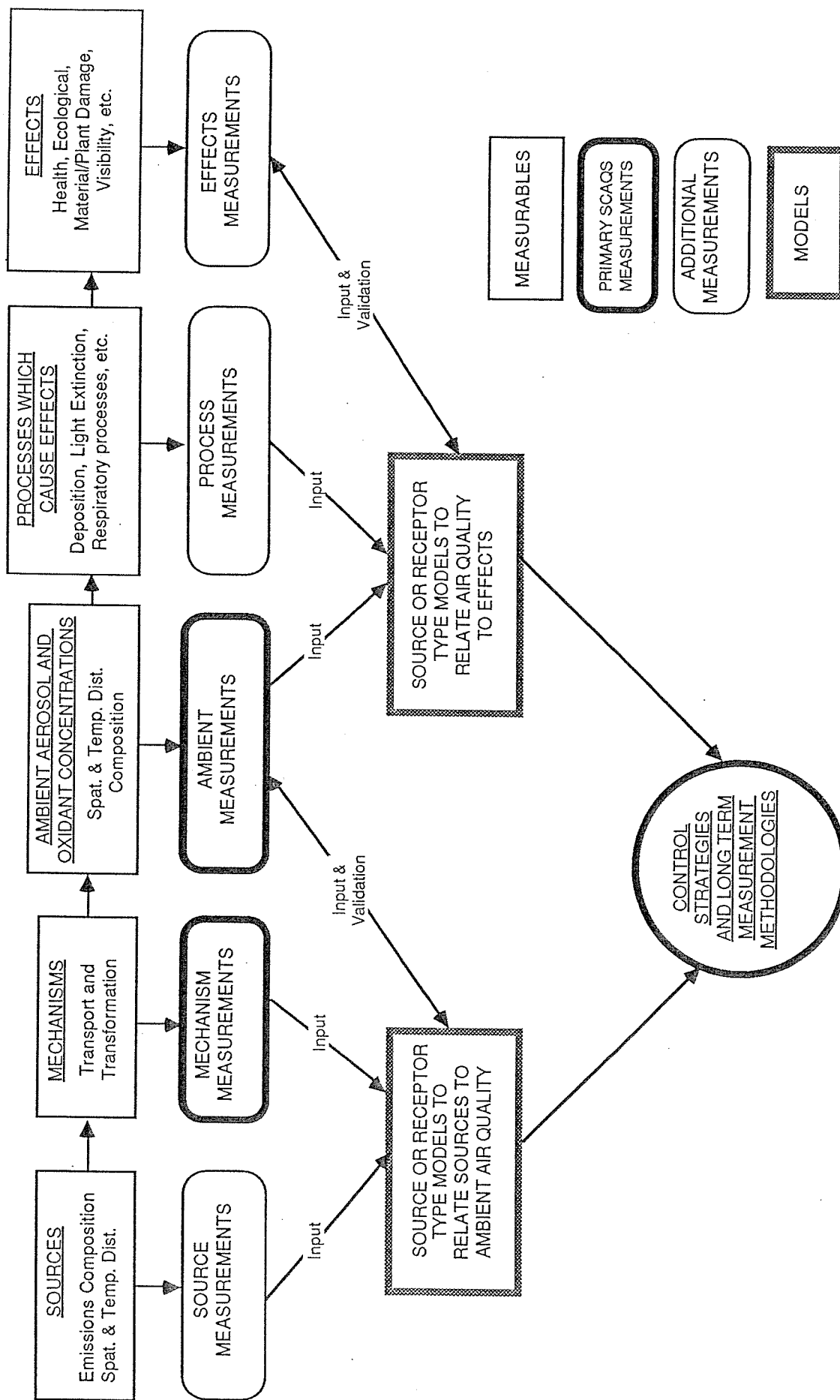


Figure 1-1. RELATIONSHIP BETWEEN MEASUREMENTS, MODELS AND CONTROL STRATEGIES

1.3 TECHNICAL OBJECTIVES

To meet the goals stated in Section 1.2, a set of program objectives has been defined. Each of these objectives can be accomplished by addressing specific technical issues. The SCAQS objectives and their related technical issues are listed in this section. The origins and importance of the issues are discussed in Section 2. The primary goal of SCAQS is to develop a data base for use by modelers. Although modeling per se is not a part of SCAQS, the modeling community has been surveyed to determine the objectives of some of the groups which will use the SCAQS data. A summary of these objectives is presented to put SCAQS in perspective.

For most modeling activities, knowledge of the physical and chemical characteristics of the emissions from the major source types is required. For many of the source types in the South Coast Basin, the chemical and physical properties of particle and hydrocarbon emissions are not well known. To improve our knowledge of these properties, some emissions characterization studies are being designed which will be complementary to and coordinated with SCAQS. The objectives of these studies are also presented in this section.

1.3.1 SCAQS Objectives and Issues

Objective 1

Obtain a data base representative of the study area and sampling periods, with specified precision, accuracy, and validity, which can be used to develop, evaluate, and test episodic source and receptor models for O_3 , NO_2 , PM-10, fine particles, and atmospheric optical properties as well as annual average models for PM-10.

Issues to be addressed:

Data should be obtained which can be used to:

describe the spatial, temporal, and size distributions, and physical and chemical characteristics of suspended particles less than 10 μm diameter;

describe the spatial and temporal distribution of O_3 and O_3 precursors including important intermediate species such as OH, HO_2 , NO_3 , H_2O_2 , and products such as $HN O_3$ and PAN;

refine the South Coast Air Basin emission inventory for the spatial and temporal distributions of particle, hydrocarbon, NO_x , and SO_x emissions for the study period;

describe the spatial distribution of selected toxic air contaminants;

describe the three-dimensional distributions of wind, temperature, relative humidity and cloud cover in the study area;

describe the initial pollutant spatial distribution and the pollutant concentrations at the boundaries of the SOCAB for the study days;

determine the relationship between the hydrocarbon/NO_x ratios in ambient air and their ratios in current emissions inventories;

determine the organic composition of selected samples of source and receptor region aerosols;

determine the contribution of trace metals to atmospheric aerosols in source and receptor areas as a function of size; and

determine the spatial distribution of nitrogen species. Perform a nitrogen mass balance across the Basin, accounting for total nitrogen species through transformations and deposition.

Objective 2

Identify the characteristics of emissions from specific sources or source types for use in receptor modeling of both gases and aerosols with emphasis on sources of organic and toxic emissions.

Issues to be addressed:

Determine which chemical and physical properties of source emissions are most useful for source attribution of receptor concentrations.

Estimate the changes in the ratios of chemical species as a function of source-receptor travel time, interactions with other species, and meteorological conditions.

Quantify the uncertainty of source attribution by receptor models as a function of the chemical and physical properties used to characterize sources. Select the optimal properties for routine source profile measurements.

Determine the percentages of the PM-10 and fine particles which are primary and secondary. Assess the relative contributions of natural and anthropogenic sources to PM-10 concentrations.

Objective 3

Assess the dependence of particle and O₃ formation and removal mechanisms upon selected meteorological and precursor variables.

Issues to be addressed:

Assess the importance of water in the vapor and liquid phases for the formation of aerosol in the SOCAB.

Assess the role of aromatic hydrocarbons in the formation of particles and as an ozone precursor.

Assess the formation rates of nitric acid and aerosol nitrate as a function of: (1) the presence of liquid water, (2) altitude, (3) UV intensity, and (4) the presence of O₃.

Estimate the rate of ozone removal at surfaces as a function of time of day and atmospheric stability.

Objective 4

Assess how the spatial and temporal distributions of particles, O_3 , O_3 precursors, and NO_x depend upon emission height and selected meteorological variables.

Issues to be addressed:

Assess the relative contribution of elevated and ground based emissions to ground level O_3 , NO_x , PM-10, and fine particle concentrations, with emphasis on the influence of elevated source emissions of NO_x on wintertime NO_2 and summertime ozone concentrations.

Assess the importance of various mechanisms for day-to-day carryover of pollutants.

Assess the effects of high temperatures upon evaporative emissions and thus on ambient concentrations of hydrocarbon species.

Objective 5

Quantify the contributions of aerosols in an upwind source region and in an eastern basin receptor region to atmospheric acidity, mutagenicity, and visibility degradation.

Issues to be addressed:

Determine the species contributing to total acidity (aerosol and gas) in source and receptor regions, and estimate the contribution of aerosol and gaseous components to total acidity and to dry deposition.

Determine the relative contributions of primary and secondary aerosol species to visibility degradation in each region.

Assess the mutagenicity of PM-10 and PM-2.5 in each region.

Objective 6

Evaluate the validity of methods of measuring PM-10, fine particles, and precursor species in quantifying atmospheric constituents as they exist in the atmosphere during sampling.

Issues to be addressed:

Determine the concentrations of liquid water in particles in source and receptor areas as a function of relative humidity (RH) and particle size. Assess the change in mass as a function of size when particles are collected on substrates and analyzed under non-ambient environmental conditions.

Determine the concentration of particulate organic matter in source and receptor areas as a function of particle size and ambient temperature. Assess the change in mass as a function of particle size, ambient temperature, and ambient pressure when particles are collected on substrates for subsequent laboratory analyses.

Determine the relationship between measurement values obtained at a single station and volume-averages over grid sizes used in prognostic air quality models.

Compare and evaluate various methods for the measurement of nitric acid and other nitrogen species and determine their accuracy, precision, and validity under a range of environmental conditions.

Compare and evaluate various methods for the measurement of carbonaceous species, and determine their accuracy, precision, and validity under a number of environmental conditions.

1.3.2 Modeling Considerations

The input and testing data required by air quality models were quantitatively assessed by a Model Working Group (MWG) as part of the program planning process (Seinfeld et al., 1986, 1987). The expected objectives of future modeling efforts include the following:

Sensitivity Testing

Performing model sensitivity tests to identify the sensitivity of model results to uncertainties in the model input data obtained during SCAQS.

Model Mechanisms Evaluation

Evaluating the physical and chemical bases for air quality models which describe photochemical and aerosol processes in the SOCAB.

Issues to be addressed:

Evaluate objective and fundamental methods of estimating three-dimensional wind fields.

Evaluate chemical and physical mechanisms for O_3 and aerosol formation.

Quantify the uncertainties in model results which are caused by: (1) measurement uncertainties of the model input data and parameters, (2) deviations from model assumptions, and (3) the stochastic nature of the atmosphere.

Compare the ability of alternative mathematical models to represent atmospheric and chemical mechanisms.

Overall Model Performance Evaluations; Performance Comparisons

Testing the performance of air quality models in predicting concentrations of PM-10, ozone, and important precursor and intermediate species as a function of space and time.

Issues to be addressed:

Identify common measures of performance applicable to all models.

Compare model results with corresponding measurements in space and time for each model tested.

Compare performance measures among air quality models.

1.3.3 Emissions Considerations

An Emissions Working Group (EWG) has been established as part of the SCAQS planning process. This group has developed a program plan for preparing the SCAQS inventory (Oliver et al., 1987). This includes procedures for collecting day-specific emission information, recommended special emission characterization studies, and a schedule for inventory delivery. This emissions inventory plan is consistent with the model input needs determined by the Model Working Group (Seinfeld et al., 1986).

1.4 OVERVIEW OF STUDY AND GUIDE TO PROGRAM PLAN

SCAQS includes the following elements:

- a project management and coordination activity;
- planning and preparation;
- measurement methods comparison and evaluation studies;
- a six week summer and a four week fall field measurement program and associated quality assurance activities;
- an emissions inventory assessment and enhancement for the study period;
- data archiving and distribution;
- data analysis and coordination activities;
- complementary emissions characterization studies for important source types; and
- reports and presentations.

Complementary model development and evaluation activities will be funded independently by some of the sponsors. This program plan describes the study elements listed above with the exception of the measurement methods comparison studies. These studies were planned separately and have been completed

(Hering and Lawson et al., 1986b and Hering et al., 1987). The results from these studies have been incorporated into the SCAQS measurement program.

The SCAQS field measurement program will take place during early to mid summer and late fall periods. During each study period, several two-day to three-day periods will be studied intensively, for a total of 18 intensive study days.

The field study will include the following elements:

- a network of existing routine air quality monitoring stations (C-sites);
- nine monitoring stations located along typical air trajectories which will measure aerosols and gases routinely on intensive study days (B-sites). B-sites will be collocated with C-sites. B-site measurements will be made by techniques of known precision and accuracy. B-site measurements will be more extensive and have better time resolution than C-site measurements. Nine B-sites will be operated in the summer period and five during the fall period;
- one research station each in a source and receptor region in the summer and one station in a source region in the fall (A-sites). These stations will be collocated with B-sites and will be the base of operations for cooperating investigators. A-site measurements will be more sophisticated and experimental than the B-site measurements;
- a network of meteorological measurements at the surface and aloft to be operated on intensive study days;
- routine upper-air pollutant and LIDAR measurements to be made by aircraft on intensive study days;
- complementary measurements of selected toxic air contaminants to be made at selected sites;
- complementary physical and chemical measurements of fog and clouds on intensive study days;
- "special" studies on selected intensive study days - including multiple tracer studies;
- assembly and archiving of complementary data from existing data sources; and
- a quality assurance program including independent systems and performance audits.

The study consists of a number of closely coordinated projects funded by several co-sponsors including the ARB, the Environmental Protection Agency (EPA), the South Coast Air Quality Management District (SCAQMD), the Coordinating Research Council (CRC), the Electric Power Research Institute

(EPRI), the Ford Motor Company, the General Motors Research Laboratories (GMRL), the Motor Vehicle Manufacturers Association (MVMA), Southern California Edison (SCE), and the Western Oil and Gas Association (WOGA). The sponsors oversee and provide guidance to the study through a Management Advisory Group (MAG). The study is being coordinated by contractors who are funded by the ARB. The management contractor has prepared a final program plan (this document) which, to the maximum extent feasible, is satisfactory to all of the members of the MAG, and the study will be conducted according to that program plan. The ARB has also funded a Data Manager who will assemble, archive, and distribute to participants all data obtained as part of the study. Agreement to abide by a data management and exchange protocol is a condition of participation in the study.

Details of the program plan are outlined in the subsequent sections. Discussions of prior studies in the SOCAB, the data needs of various types of models, and the existing data resources in the SOCAB are presented in Section 2. Details of the planned measurements and emissions assessments are presented in Section 3, and the approach to quality assurance is discussed in Section 4. The data management activities and protocol are outlined in Section 5. Data analysis and complementary modeling activities are discussed in Section 6, and the program management structure is described in Section 7. The contracts related to the study, and the contributions of various sponsors are discussed in Section 8.

The preparation of this plan has been an iterative process. This fourth and final version of the SCAQS program plan incorporates additions, corrections, and changes in scope which resulted from review of the three previous versions by the ARB, sponsors, participants and the scientific community. As part of the planning process, Emissions, Meteorology, and Model Working Groups were formed to review the plan and to recommend specific measurement and data collection activities which would ensure that the study will meet the needs of the analysts and modelers who will use the data. The plan which has evolved is consistent with the recommendations of the working groups.

2. CURRENT KNOWLEDGE AND INFORMATION NEEDS

2.1 AIR QUALITY MANAGEMENT PLAN

The South Coast Air Basin (SOCAB) comprises 6600 square miles of the non-desert portions of Los Angeles, San Bernardino, Riverside and Orange Counties. Its population of approximately 10.5 million inhabitants is expected to increase to 13 million by the year 2000. This will be accompanied by a 31% increase in the number of dwellings and a 33% increase in employment. It is expected that 10.1 million on-road vehicles in the Basin will travel 234.3 million miles per day by the year 2000 (SCAQMD, 1982). The tremendous growth predicted over the next two decades adds to the even more rapid growth which has occurred since 1950. This growth has been accompanied by deterioration of air quality. Without careful planning and appropriate emissions controls, air quality could become even worse in the future.

The South Coast Air Quality Management District (SCAQMD) is charged with the responsibility for determining compliance with California state and federal air quality standards, proposing plans to attain those standards when they are exceeded, and for implementing those plans to the greatest extent possible. To these ends, the SCAQMD operates a network of sampling sites, illustrated in Figure 2-1, which measure ambient concentrations of carbon monoxide (CO), ozone (O₃), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), total suspended particulate (TSP) matter, PM-10, and suspended particulate lead. Table 2-1 presents the federal primary and secondary and California state standards for different atmospheric pollutants along with the number of sites and number of days in 1982 which exceeded these standards (Hoggan et al., 1983). Recent data for 1983 (ARB, 1983, and Hoggan et al., 1984) and earlier years are consistent with the number of exceedance cases indicated in Table 2-1. It is evident that the South Coast Air Basin was in violation of every standard, except that for SO₂, at nearly every one of its sampling sites during 1982. Results for 1983, 1984, 1985 are similar and pollution levels in subsequent years are not expected to change significantly without changes in emissions. There is an obvious need to undertake measures to reduce ambient concentrations of carbon monoxide, nitrogen dioxide, ozone, and suspended particulate matter.

The most recent Air Quality Maintenance Plan (AQMP) (SCAQMD, 1982) proposes several control measures which would be implemented between now and the year 2000. SCAQMD (1982) estimates that these "Short Range Control Tactics" will cost approximately \$800 million to implement, most of which will be borne by petroleum refineries, electric utilities, and motor vehicle manufacturers. The emissions reductions are in addition to control measures which had been mandated prior to the Plan. The largest emission reductions by the year 2000 proposed in this plan result from the following additional control measures:

- Major CO reductions will result from more frequent tuneups to manufacturers' specifications; low emission, high fuel economy vehicles for local government; increased bicycling; ride sharing; modified work schedules; home goods delivery; traffic signal synchronization; electric, methanol-powered and dual-fueled vehicles; and more stringent emissions controls on in-use and new vehicles.

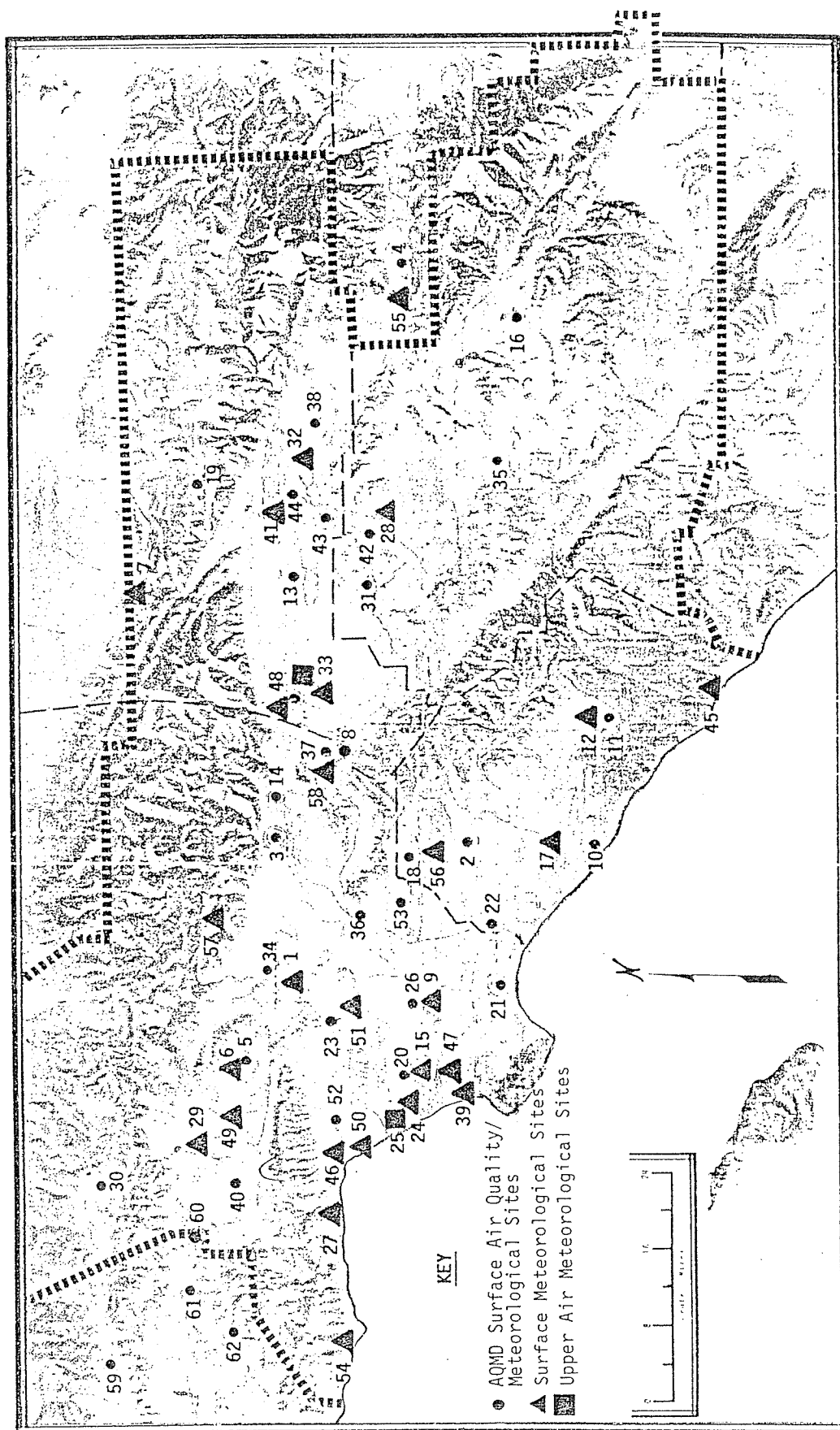


Figure 2-1. Existing Air Quality and Meteorological Monitoring Sites in the South Coast Air Basin.
(Site codes are listed in Table 2-3 on pages 2-20 through 2-22.)

Table 2-1. Federal and California State Standards with Number of Sites (d) Exceeding them in 1982.

| Pollutant | Federal Primary Standard | No. of Sites in Violation | Range in No. of Violation Days per site | Federal Secondary Standard | No. of Sites in Violation | Range in No. of Violation Days per site | California State Standard | No. of Sites in Violation | Range in No. of Violation Days per site |
|------------------|---------------------------------------|---------------------------|---|---------------------------------------|---------------------------|---|-------------------------------------|---------------------------|---|
| Ozone | 0.12 ppm (1 hr) | 32 | 1 to 121 | 0.12 ppm (1 hr) | 32 | 1 to 121 | 0.10 ppm (1 hr) (a) | 33 | 2 to 160 |
| Carbon Monoxide | 9.0 ppm (8 hr) 35.0 ppm (1 hr) | 13 0 | 2 to 50 0 | 9.0 ppm (8 hr) 35.0 ppm (1 hr) | 13 0 | 2 to 50 0 | 9.0 ppm (8 hr) 20.0 ppm (1 hr) | 13 6 | 2 to 47 1 to 7 |
| Nitrogen Dioxide | 0.05 ppm (aaa) (f) | 9 | NA (c) | 0.05 ppm (aaa) | 9 | NA | -- | -- | -- |
| | -- | -- | -- | -- | -- | -- | 0.25 ppm (1 hr) | 11 | 1 to 8 |
| Sulfur Dioxide | 0.03 ppm (aaa) 0.14 ppm (24 hr) | 0 0 | 0 0 | 0.03 ppm (aaa) | 0 | 0 | -- | -- | -- |
| | -- | -- | -- | -- | -- | -- | 0.05 ppm (24 hr) | 0 | 0 |
| Sulfate | -- | -- | -- | -- | -- | -- | 25 µg/m ³ (24 hr) | 14 | 1 to 3 |
| Lead | 1.5 µg/m ³ (calendar qtr.) | 1 (b) | 1 (b) | 1.5 µg/m ³ (calendar qtr.) | 1 (b) | 1 (b) | 1.5 µg/m ³ (per 30 days) | 2 (b) | 1 to 3 (b) |
| TSP | 75 µg/m ³ (aga) (g) | 14 | NA | 60 µg/m ³ (aga) | 18 | NA | 60 µg/m ³ (aga) | 18 | NA |
| | 260 µg/m ³ (24 hr) | 4 | 1 to 2 | 150 µg/m ³ (24 hr) | 23 | 1 to 22 | 100 µg/m ³ (24 hr) | 26 | 2 to 37 |
| PM-10 | 50 µg/m ³ (aaa) | -- | -- | -- | -- | -- | 30 µg/m ³ (aga) | -- | -- |
| | 150 µg/m ³ (24 hr) | -- | -- | -- | -- | -- | 50 µg/m ³ (24 hr) | -- | -- |

(a) Oxidant instead of ozone

(b) Number of quarters instead of number of days

(c) NA - not applicable for annual average

(d) Out of a total of 35 sites for O₃, 27 sites for CO, 24 sites for NO₂, 21 sites for SO₂, and 27 sites for TSP, lead, and sulfate.

(e) Only sites exceeding the standard at least once are included.

(f) aaa = annual arithmetic average

(g) aga = annual geometric average

- Major SO₂ reductions will result from flue gas desulfurization on fluid cracking units, electric utility boiler modifications, weatherproofing of existing homes, insulation standards for new homes, and greater reliance on wind energy.
- Major primary particulate reductions will result from paving roads and vehicular emissions controls.
- Major nitrogen oxides (NO_x) reductions will result from controls on stationary internal combustion engines, truck freight consolidation terminals, additional emissions controls on in-use and new motor vehicles, introduction of electric vehicles, electrification of railroad line haul operations, emissions standards for off-road heavy duty equipment, and improved home insulation.
- Major reactive organic species reductions will result from controls on thermally enhanced oil recovery and wood furniture finishes, changes in aerosol spray can contents and other consumer solvents, ride sharing, modified work schedules, reduction of the number of aircraft engines involved in idle and taxi operations, further controls on in-use and new vehicles, methanol fleet conversion, emissions standards for new boats and pleasure craft, and new source review.

If these measures are implemented, it is anticipated that the SCAQMD will continue to be in compliance with the federal SO₂ standard and will attain the federal NO₂ standard. Though attainment of the CO standard is not predicted by the AQMP analysis, this standard is exceeded at only a few sites, and the proposed emissions reductions bring the total to within 1.5% of the emissions estimated for CO attainment.

However, the reductions in precursor gas and primary particle emissions would be insufficient to predict attainment of the ozone and suspended particulate matter standards. Additional controls with existing technology are problematic, and the AQMP is not expected to yield attainment of these standards by the year 2000.

The AQMP is constantly being changed in response to new information and new standards: "...both the AQMP and the 1982 Revision are interim reports which represent the most complete information which could be gathered within the time and resources available....New approaches and new ways of assessing the problems are required if the region is to meet its air quality goals without serious economic and social disruption." (SCAQMD, 1982). SCAQS will provide these new ways of assessing problems if the objectives stated in Section 1 can be met.

2.2 AIR POLLUTION CHARACTERISTICS OF THE SOUTH COAST AIR BASIN

The key components of air pollution are emissions, transport and transformation, and receptor concentrations. This subsection provides a brief summary of knowledge about these components in the South Coast Air Basin. Emphasis is given to effects of these components on particulate matter and ozone concentrations at receptors. Effects on atmospheric acidity, toxic air contaminants, and visibility are inextricably related to the concerns about ozone and suspended particulate matter.

2.2.1 Emissions

Table 2-2 presents the SOCAB emissions classified into six categories as compiled from the 1983 emissions inventory (ARB, 1986). Total emissions from the state of California are given for comparison. The emissions in several of these categories have changed since the 1979 inventory as the result of the implementation of controls on various sources and fuel switching (from oil to natural gas) in the utility industry.

The first observation from this table is that the SOCAB contained a large fraction of all emissions in the state during 1983, ranging from 26% to 38%. Furthermore, this large fraction of total state emissions was confined to only 4% of the state's land area and is roughly comparable with the area's 44% of the state population. The largest emitters of both reactive organic gases (ROG) and nitrogen oxides in 1983 were on-road vehicles. Light duty passenger vehicles and light and medium duty trucks were the largest contributors within this source category, though heavy duty diesel trucks were significant NO_x emitters. Solvent use was a major emitter of reactive organic gases, with architectural coatings, other surface coatings, and domestic uses being its major sources. Fuel combustion was also a major NO_x emitter, with the electric utilities being the highest contributor within this category. The large total organic gas (TOG) emission rate derived largely from solid waste landfills. Tilling, re-suspended road dust, and light-duty passenger vehicle emissions were the major primary particle emitters, with diesel trucks and mineral processing also of significance.

There are slight seasonal deviations in these Basin-wide emission rates; these changes are typically within the measurement uncertainty of the inventory process (Grisinger et al., 1982). Seasonal differences are related primarily to weather conditions, with higher fuel consumption in the wintertime for heating. Reactive organic emissions are higher in the summer owing to the use of paints in construction. The increased CO and particle emissions from fuel combustion in the winter are somewhat offset by negligible winter emissions from the unplanned fires which take place intermittently during the hot summer months. Thus, while the aggregate emission rates do not vary appreciably over the year, the temporal and spatial detail of these emissions varies significantly. Figures 2-2 and 2-3 show the gridded emissions of TOG, CO, NO_x , SO_x , and TSP from surface and elevated point sources. These figures illustrate the spatial complexity of emissions in the SOCAB. They represent 1982 emissions projections from 1979 data. The vertical scales of each figure are unequal, so comparisons among Figure 2-2, Figure 2-3, and Table 2-2 must be qualitative. Nevertheless, several inferences can be made. Surface emissions of TOG, CO, and NO_x have similar spatial distributions. These emissions are highest near the center of the Basin and taper off near the coastal areas and toward the eastern extremes. Table 2-2 implies that the major sources of these species are on-road vehicles. Surface SO_x emissions are most concentrated near and southeast of the Palos Verdes peninsula. Table 2-2 implies that petroleum transfer and storage and low-level combustion of sulfur-containing fuels take place in these grid squares. Surface particulate emissions are more uniformly distributed throughout the Basin with several large peaks which are probably attributable to some of the "miscellaneous processes" listed in Table 2-2. The downtown particle peak corresponds to similar patterns on the TOG, CO, and NO_x plots and can probably be attributed

Table 2-2. 1983 Emission Rates(a) in the South Coast Air Basin Compared to Those of California (Emission rates in tons/day based on one year of emissions)

| Emissions Source Categories | Location | Total Organic Gases (TOG) | Reactive Organic Gases (ROG) | Carbon Monoxide (CO) | Nitrogen Oxides (NO _x) | Sulfur Oxides (SO _x) | Particulate Matter < 10 um (PM-10) |
|--|--------------|---------------------------|------------------------------|----------------------|------------------------------------|----------------------------------|------------------------------------|
| Fuel Combustion | SOCAB Calif. | 42 150 | 17 71 | 84 470 | 240 770 | 22 220 | 12 88 |
| Waste Burning | SOCAB Calif. | 1 96 | 1 46 | 3 920 | 0 2 | 0 1 | 0 86 |
| Solvent Use | SOCAB Calif. | 430 920 | 390 850 | 0 0 | 0 0 | 0 0 | 1 1 |
| Petroleum Processing, Transfer & Storage | SOCAB Calif. | 370 1300 | 110 600 | 14 84 | 14 26 | 36 95 | 4 8 |
| Industrial Processes | SOCAB Calif. | 25 79 | 21 66 | 80 200 | 12 40 | 13 38 | 15 85 |
| Misc. Processes | SOCAB Calif. | 530 2400 | 64 260 | 44 300 | 2 5 | 0 0 | 640 2400 |
| On-Road Vehicles | SOCAB Calif. | 710 1800 | 670 1700 | 5300 12000 | 630 1700 | 50 130 | 48 140 |
| Other Mobile Sources | SOCAB Calif. | 79 320 | 75 300 | 460 1600 | 130 460 | 32 84 | 12 59 |
| All Sources (annual) | SOCAB Calif. | 2200 7000 | 1400 3800 | 6000 16000 | 1000 3000 | 150 570 | 740 2900 |
| Uncertainty(b) | SOCAB | | +10% | +16% | +11% | +9% | +19% |

(a) Data from ARB (1986). TOG and ROG in equivalent weights of CH₄, NO_x in equivalent weights of NO₂, SO_x in equivalent weights of SO₂, and PM-10 contains all particles less than 10 um. Note that sums are rounded to two significant figures, since uncertainties don't justify more than that.

(b) Composite relative uncertainty of total emissions derived from subjective estimates for individual source type emissions which range from +15% to +100% from Grisinger et al. (1982). Uncertainties are much higher for size and time-resolved emissions rates.

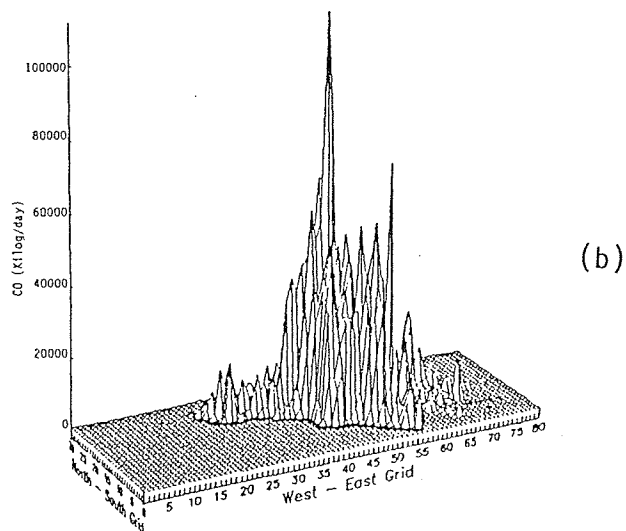
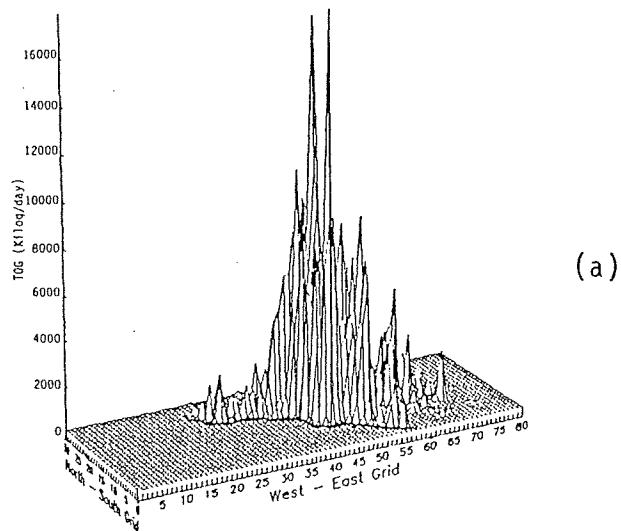


Figure 2-2. Spatial Pattern of Surface Emissions (<10 m AGL) in the South Coast Air Basin. These Data are 1982 Projections from the 1979 Emission Inventory for TOG (a), CO (b), NO_x (c), SO_x (d), and TSP (e) (personal communication with Ed Yotter of ARB, (1986).

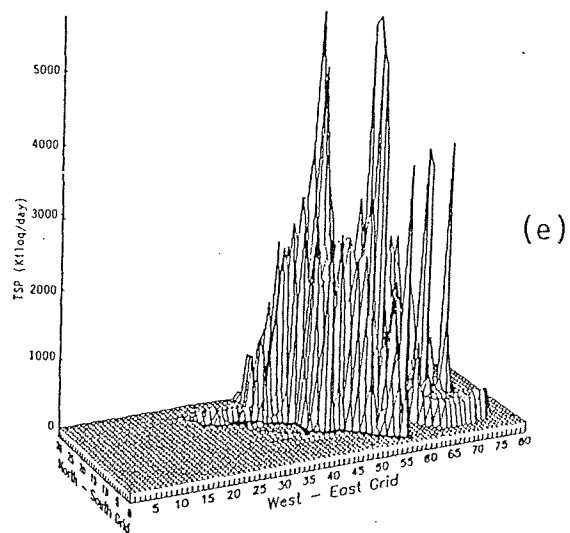
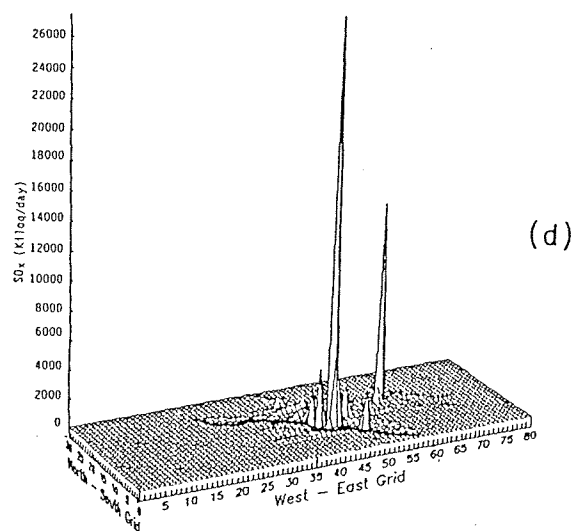
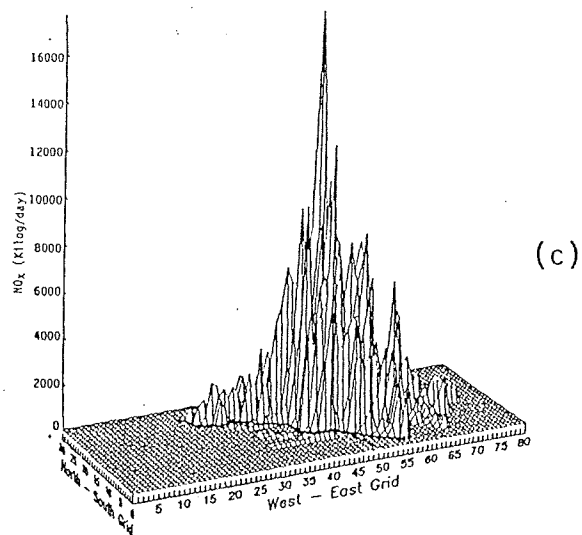


Figure 2-2. (Continued)

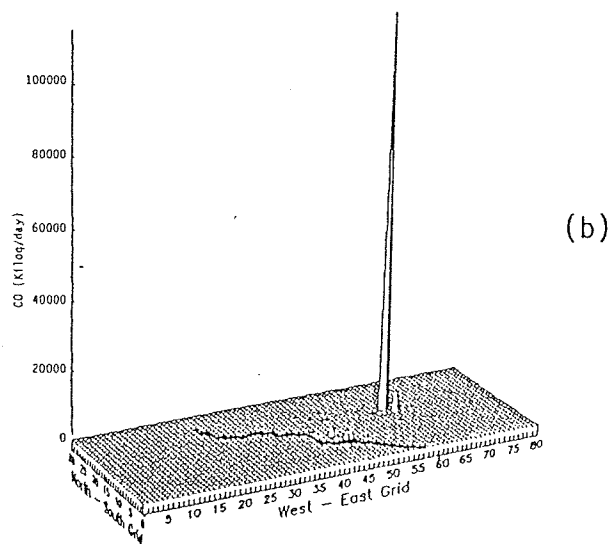
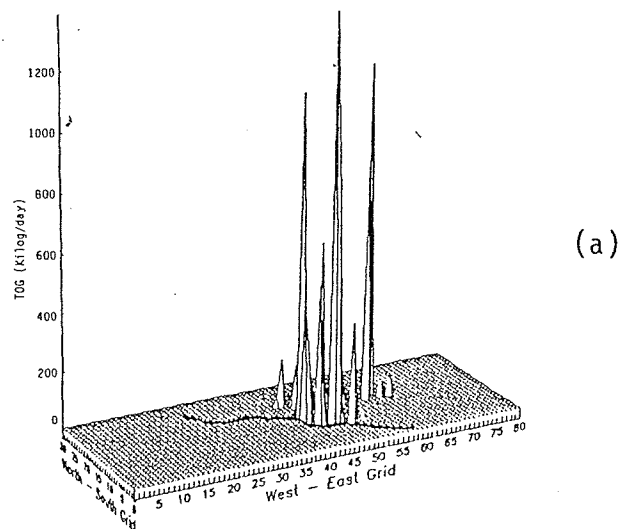


Figure 2-3. Spatial Pattern of Elevated Emissions (>10 m AGL) in the South Coast Air Basin. These Data are 1982 Projections from the 1979 Emission Inventory for TOG (a), CO (b), NO_x (c), SO_x (d), and TSP (e) (personal communication with Ed Yotter of ARB, 1986).

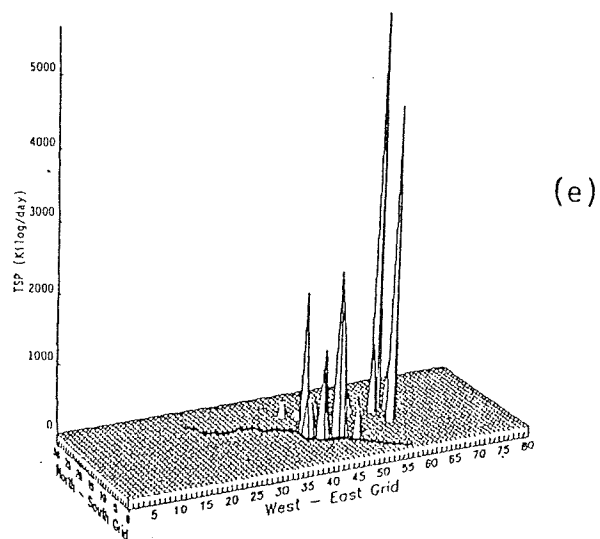
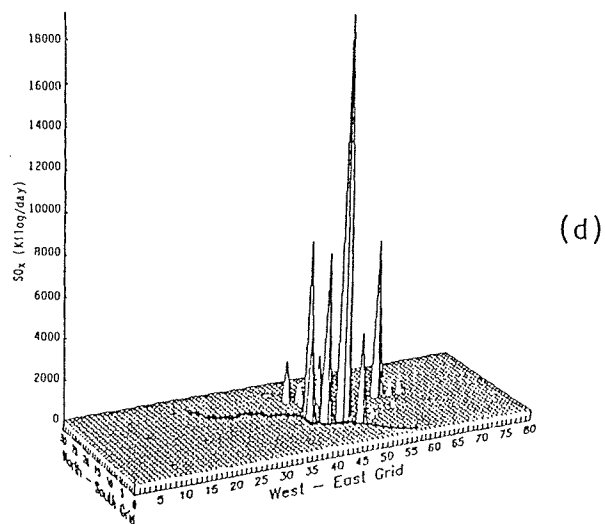
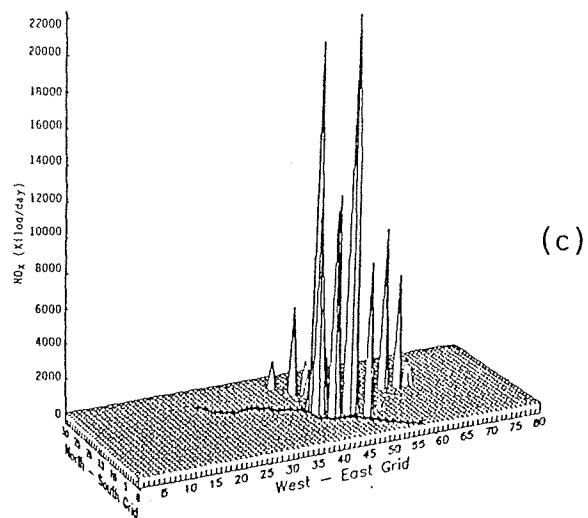


Figure 2-3. (Continued)

to re-suspended road dust. The east Basin peaks could be attributable to agricultural tilling.

The peaks for all pollutant emissions in Figure 2-3 originate from the same point sources, and they are relatively few. Grisinger et al. (1982) list these sources and their location in order of emission rate. These elevated emitters are concentrated along the middle and southern coast with a few located in the east Basin. NO_x appears to be the most widely distributed elevated source, and many of its isolated appearances probably result from natural gas combustion which is accompanied by few other pollutant emissions. The elevated emissions of suspended particulate matter are more isolated in space than are the surface emissions, but their emissions rates are comparable to or greater than the surface rates in corresponding grid squares.

The temporal variations in pollutant emissions are not well documented. Though Grisinger et al. (1982) provide diurnal patterns for on-road vehicle emissions which show peaks during the morning and evening rush hours and lower than average emissions at night, these patterns are inferred rather than measured. SCAQMD receives daily NO_x emission rates from large stationary sources, but these are not formally incorporated into the inventory process. The ambient concentration changes observed during the 1984 Olympics by Davidson and Cassmassi (1985) indicate that temporal emission distributions may have an important effect on the products of those emissions.

The ARB and SCAQMD emissions inventory for the South Coast Air Basin is one of the best of its type in existence. Nevertheless, it contains uncertainties which derive from errors in the vast amount of acquired data, emission factors which are not derived from the specific emissions sources, and variable or undocumented process rates. The emission rates reported in Table 2-2 reflect activities as they were in 1983. Even though SCAQMD (1982) has made projections into 1987, these projections are no substitute for a re-assessment of the emitting sources during the year of concern.

The 1983 inventory may not even present an entirely accurate picture for that year. Emission rates from stationary sources which exceed 10 tons/year are updated with each inventory revision from approximately 65,000 permits filed by 10,000 companies. Emissions from smaller sources are not routinely re-estimated, and these can account for more than 50% of the reactive organic gas emissions from stationary sources. Biogenic and geogenic emissions are not included in the inventory, and these could be significant.

Grisinger et al. (1982) provide semi-quantitative estimates of the uncertainty of emission rates for the 1979 inventory, and the Basin-wide estimates recorded in Table 2-2 are tolerable for most assessment purposes. The individual emissions category uncertainties, however, range from 15% to 100% (these coefficients of variation are one standard deviation centered on the average emission rate estimate). Uncertainties for ROG rates from major emission categories such as surface coatings and gasoline hot soak and evaporation are especially large (30% to 40%). Uncertainties associated with smaller spatial scales and time intervals probably are much higher than these estimates.

One specific concern involves the uncertainty of the ratio of reactive hydrocarbons to nitrogen oxides (NO_x) emissions which is used in the EKMA

modeling (Liu, 1982) for the AQMP. The Basin-wide ratio for these emissions is approximately 3.5 while ambient measurements in the downtown area yield an average ratio of 10.3. (The ROG/NO_x ratio is based on volumetric concentrations of these gases. The mass emission rates in Table 2-2 must be converted by a factor equal to the ratio of their molecular weights.) This inconsistency can be explained by (1) inaccurate ROG or NO_x emission rates, (2) ROG and NO_x chemical reactions in the atmosphere, including different deposition rates, or (3) inaccurate measurements of ambient ROG and NO_x. Oliver and Peoples (1985) re-examined the 1979 inventory with respect to hydrocarbon and NO_x emissions from stationary and off-road mobile sources. They found some evidence of double counting, missing sources, and inconsistent use of emissions factors. Their corrections to the 1979 inventory amounted to 0.2%, 1.0%, and -3.0% adjustments to the Basin-wide rates for TOG, ROG, and NO_x, respectively, being emitted by stationary and off-road mobile sources. However, the relative adjustments within specific source categories were larger.

The PM-10 particulate emissions in Table 2-2 are also highly uncertain. In fact, the 1983 inventory is the first complete inventory to include size-specific emissions information. Improved size-specific emissions measurements are being made as part of the AQMP process and as part of the 1987 major inventory update.

Grisinger et al. (1982) also call attention to the need to add ammonia emissions, better hydrocarbon profiles, and chemical speciation of emitted particulate matter (including hazardous substances) to the inventory. Ammonia is needed because of its potential involvement in the secondary fraction of PM-10. The hydrocarbon profiles are needed to separate ROG into reactivity categories. Several of these categories have been proposed and compared (e.g. Trijonis et al., 1978a) and others have been defined for air quality modeling. These hydrocarbon profiles can also be combined with other properties of the emissions to apportion ambient concentrations to their sources (e.g. Mayrsohn and Crabtree, 1976, Mayrsohn et al., 1977; Feigley and Jeffries, 1979). Chemical speciation of particulate matter is also necessary to apportion sources (e.g. Friedlander, 1973) and because of the roles of certain species in sulfur oxidation and atmospheric acidity. Abatement of toxic material concentrations will also require chemical-specific inventories for these species. Though Taback et al. (1979), Parungo et al. (1980), Rodes and Holland (1981), Dzubay et al. (1979), Miller et al. (1972), and Oliver and Peoples (1985) have made several chemically-specific measurements of source emissions in the SOCAB, no comprehensive data of the important components are yet available for any SOCAB source category.

2.2.2 Transport, Transformation, and Deposition

Transport, transformation and deposition are treated together because of the large effects which meteorological conditions have on the movement and changes of pollutants. These phenomena have been, and continue to be, subjects of intensive research on which volumes have been written. The intent here is to identify the subject areas of importance for particle and oxidant concentrations in the South Coast Air Basin. The data acquired in SCAQS will be used to elucidate these transport and transformation phenomena.

Southern California is in the semi-permanent high pressure zone of the eastern Pacific. It experiences hot summers, and rainfall is sparse and occurs

mostly during winter. Frequent and persistent temperature inversions are caused by subsidence of descending air warmed by compression settling over the cool, moist marine air. These inversions often occur during periods of maximum solar radiation (SCAQMD, 1982). Relative humidities can vary, depending on the origin of the air mass. RH typically exceeds 50% throughout the basin, being higher near the coast than farther inland (Smith et al., 1984).

As illustrated in Figure 2-1, the SOCAB is surrounded on the north, east, and west by mountains, some of which rise above 10,000 feet. The Basin opens to the Pacific Ocean on the southwest. The topography of the Basin combined with the land/sea interface introduces important mesoscale effects which are superimposed on the synoptic weather patterns.

Figures 2-4 and 2-5 from Smith et al. (1972) illustrate the diurnal evolution of surface flow patterns in the SOCAB for summer and winter months respectively. Similar patterns were found by Keith and Selik (1977). In the summertime, the sea breeze is strong during the day and there is a weak land-mountain breeze at night. Because of the high summer temperatures, the land temperature does not usually fall below the water temperature at night, and the nocturnal winds are slow and weak. The opposite is true during the winter, when the mountain-land breeze at night yields strong ventilation, and a mild sea breeze is only established late in the day when temperatures approach their maxima.

The predominant trajectories are from the west and south during summer mornings, switching to predominantly westerly flows by the late afternoon and early evening. These summertime trajectories become difficult to discern at night owing to the generally stagnant conditions. As shown in Figure 2-5, the prevailing wintertime trajectories are from the east and north at night, switching to westerly trajectories by late afternoon. In both cases, there is strong propensity for the transport of emissions from the western and southern parts of the SOCAB to the eastern and northern parts, with this propensity being higher during the summer months than in the winter months. Aircraft (e.g. Blumenthal et al., 1978; Calvert 1976a, 1976b), tetroon (e.g. Angell et al., 1976), and tracer (e.g. Shair et al., 1982) studies provide results which are qualitatively consistent with the trajectories illustrated in Figures 2-4 and 2-5.

The land/sea breeze circulation can cause air to transfer back and forth between the Basin and the Pacific Ocean. Cass and Shair (1984) estimated that up to 50% of the sulfate measured at Lennox was attributable to backwash of emissions which had been transported to sea on the previous day. During the daytime, emissions from coastal sources are advected inland by the sea breeze. At night, these polluted air masses are swept back toward the coast to await their re-entry to the Basin on the following day. There is ample evidence (e.g. Kauper and Niemann, 1975; 1977), however, that a good portion of these pollutants which pass the coastline can be transported to neighboring air basins.

Air from the Basin can exit through a number of routes other than the sea. Smith and Shair (1983) found transport routes through Soledad Canyon, Cajon Pass, and San Geronio Pass when they released tracer gases in the South Coast Air Basin. Smith and Shair (1983) also showed evidence of transport aloft from the San Fernando Valley into eastern Ventura County. Godden and

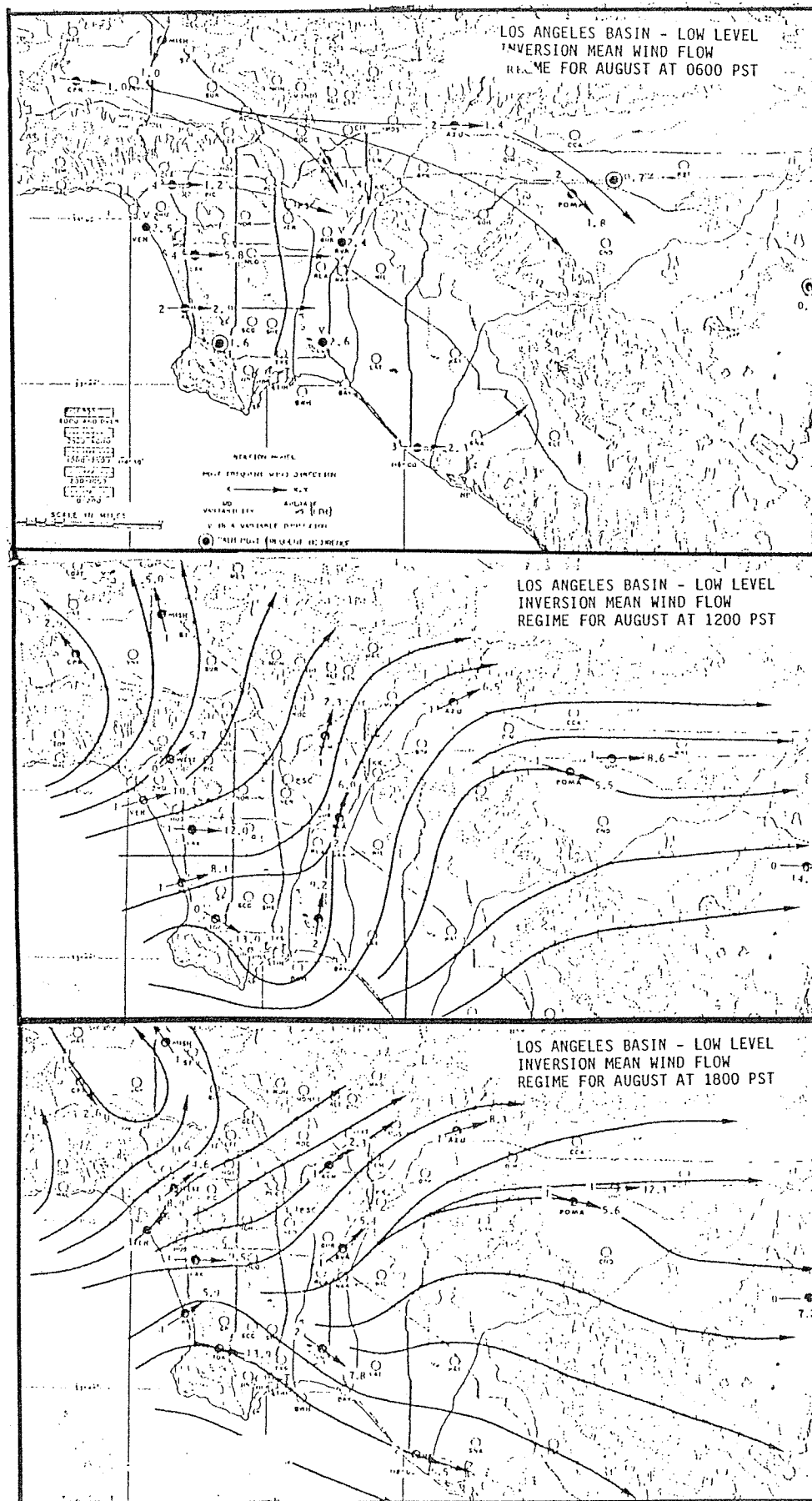


Figure 2-4. Summer Variation in Surface Wind Flow Patterns throughout the Day in the South Coast Air Basin (Smith et al., 1972).

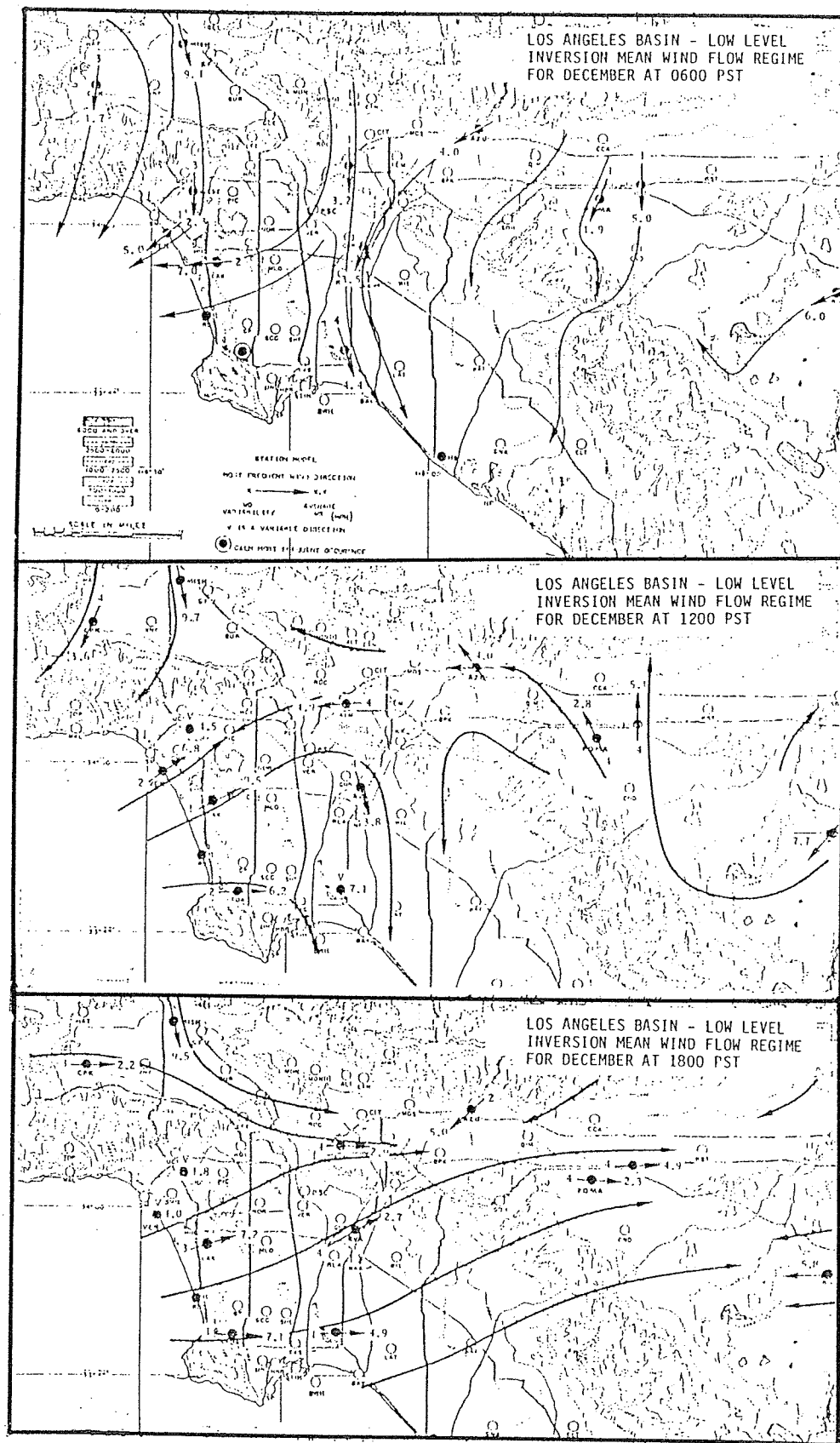


Figure 2-5. Winter Variation in Surface Wind Flow Patterns throughout the Day in the South Coast Air Basin (Smith et al., 1972).

Lague (1983) note, however, that tracer experiments also provide "...circumstantial evidence...that pollutants can be transported both from Ventura County through the Simi Hills and along the coast to West Los Angeles...".

Smith et al. (1984) have made a comprehensive study of air pollution climatologies in California. In addition to the above observations, Smith et al. (1984) note the potential for slope flows and convergence zones in the SOCAB. Slope flows provide a mechanism for the transport of pollutants from below the inversion to above. They occur when the mountains absorb solar radiation and heat the surrounding air, making it more buoyant. Smith et al. (1984) comment that "In areas such as the South Coast Air Basin, this transport mechanism provides one of the more effective methods of removing pollutants from the Basin." This upslope flow can result in high pollutant concentrations at elevated locations. These locations would not normally experience such pollution due to their own local emissions.

Convergence zones occur where terrain and pressure-gradients direct wind flows in opposite directions; the convergence results in an upwelling of air, and a consequent transport of pollutants to higher elevations. These convergence zones can also restrict the transport of pollutants from one basin to another. Smith et al. (1984) plot SOCAB convergence zones at Elsinore (McElroy et al., 1982; Smith and Edinger, 1984), the San Fernando Valley (Edinger and Helvey, 1961), El Mirage, the Coachella Valley, and Ventura.

Several of these meteorological features (upslope flow, convergence zones, marine air intrusions, transport into the stable layer, and plume rise from elevated sources) inject pollutants above the mixed layer. As the mixing depth increases during the day, some of these elevated pollutants can become re-entrained in the mixed layer and advected to ground level.

Smith et al. (1984) comment that "... The primary source of uncertainty in defining meteorological air pollution potential in the state lies in the description of mixing height behavior, particularly in the coastal areas where mixing height changes significantly with distance inland." Smith et al. (1984) believe that current SOCAB upper air measurements should be supplemented with additional soundings in the San Bernardino/Riverside area. While these complex meteorological phenomena affecting pollution potential are qualitatively simple, their quantitative description is much more difficult.

In addition to atmospheric movements, temperature, insolation, and relative humidity affect the transformations of precursor gases to ozone and suspended particulate matter. Photochemical transformations are probably the most important of these, and they have been recognized as important since the days of Haagen-Smit in the early 1950s. Ozone plus the sulfate, nitrate and organic fractions of the aerosol are influenced by photochemical processes.

The photochemical influence on ozone formation is well established in the SOCAB in laboratory studies (e.g. Kopczynski et al., 1972), in semi-coherent air parcels sampled with airborne platforms (e.g. Calvert, 1976a, 1976b; Feigley and Jeffries, 1979; Spicer et al., 1983) and at fixed ground stations (e.g. Spicer, 1977; Reynolds et al., 1974; McRae and Seinfeld, 1983; Godden and Lurmann, 1983) which represent SOCAB atmospheres. Measurements in these studies all show a morning buildup (or high initial concentration) of NO from fresh emissions, followed a few hours later by a dramatic decrease in NO and

peak of NO_2 , which is in turn followed by a peak in ozone concentrations in the early to late afternoon (depending on the location of the sampling site). While these qualitative features are well-established and reproducible, the chemistry and physics describing them is not. Dunker et al. (1984), Leone and Seinfeld (1984a, 1984b), and Killus and Whitten (1983) have compared the most recent photochemical reaction mechanisms applied to similar situations. Though all mechanisms exhibit the same qualitative features of reactant and end-product concentrations with time, the peak values and the time of occurrence of those peaks are mechanism dependent. The practical mechanism which is most representative of reality is still open to judgment.

Photochemical sulfate formation in the Los Angeles atmosphere typically follows a diurnal cycle with a daytime maximum rate near 6% per hour (Roberts, 1975; Cass, 1981). Nitrogen dioxide is converted to nitric acid by hydroxyl radicals at rates five to ten times faster than sulfur dioxide is converted to sulfate (Forrest et al., 1981). Nitrogen dioxide is also converted to peroxyacetyl nitrate (PAN), and the proportions depend on the initial ROG/NO_x ratios (Spicer et al., 1983). Russell et al. (1985) found that over a 24 hour trajectory simulation, 7% of NO_x emissions were transformed to airborne HNO_3 . Though both nitric acid and PAN are gases, nitric acid is also present in liquid particles. The photochemical formation of organic aerosol is less well understood (Pitts et al., 1978; Hidy and Mueller, 1979), but is the subject of much current work. Studies of organic aerosol formation are inconclusive because of the plethora of precursors and the volatilities of their products. Theoretical mechanisms for the photochemical conversion of gases to particles are still in their formative stages.

The differences between inventoried and ambient ROG/NO_x ratios can be explained, at least in part, by these theoretical reaction mechanisms. Haney and Seigneur (1985) re-examined the ambient ROG and NO_x concentrations generated by a recent application of the SAI urban airshed model to the SOCAB which used an initial ROG/NO_x emissions ratio of 2.86. They found that the ROG/NO_x ratios at Anaheim and Downtown L.A. reached values of 7 to 9 during the hours just past noon and dropped to values of 3 to 5 at night. The afternoon values correspond to the period of maximum ozone production, when a large portion of the ambient NO_x is reduced by photochemical reactions. Photochemistry ceases after sunset, allowing the NO_x to be replenished. Calculations for Riverside show ratios ranging from 4.5 to 61.7 because the pollutants have undergone longer photochemical reaction times and ambient NO_x levels are much lower than those at the downtown sites. Haney and Seigneur (1985) conclude that the faster oxidation of NO_x with respect to ROG during photochemical smog formation can account for the difference between inventoried and ambient ROG/NO_x ratios and that neither the inventory nor the ambient measurements are necessarily in error.

Though photochemical transformation processes are of greatest importance for the production of ozone, gases can be transformed into suspended particulate matter by a number of other processes. Husar et al. (1976) show direct evidence of the condensation of gaseous species on solid or liquid particles. Relative humidity changes affect the water content of aerosols, which have consequences with respect to their size and their propensity to scatter light (Charlson et al., 1969; Covert et al., 1972; Tang et al., 1981). This effect tends to be important at relative humidities above 70% when many dry, ionic particles deliquesce. Sulfate formation rates increase when small

particles in solution are present in the atmosphere (Cass, 1975; Dittenhoeffer and dePena, 1978; Gillani and Wilson, 1983; Gillani et al., 1983). Under these conditions, the growth of relatively large particles can be favored (McMurry and Wilson, 1980; Hering and Friedlander, 1982).

Particles can also form in fog and clouds because soluble particles are preferentially activated during the formation of clouds and fog, and ionic species formed in fog or cloud water will become part of these particles when the fog or clouds evaporate. This mechanism has been inferred from models (e.g. Chameides and Davis, 1982; Seigneur and Saxeena, 1984; Young et al., 1983; Jacob and Hoffmann, 1983), from rain chemistry (Lazrus et al., 1983), and cloud measurements (Richards et al., 1983a, 1983b; Daum et al., 1983). Catalysis by trace metals such as manganese and iron may be important in sulfate formation in fog and clouds (Martin, 1983; Young et al., 1983; Jacob and Hoffmann, 1983; Seigneur and Saxeena, 1984; Seigneur et al., 1985). Nitric acid has been shown to be rapidly scavenged by fog or clouds (Levine and Schwartz, 1982).

The non-photochemical particle formation mechanisms may be especially influential at night and during winter periods. Richards (1983) proposes a mechanism in which ozone aloft reacts with NO_x to form nitrate. Richards (1983) speculates that this mechanism may explain the high morning concentrations of large particle nitrate which were observed by Appel et al. (1978). Recent theoretical formulations of these particle formation mechanisms have been developed for incorporation into the comprehensive mathematical models describing the SOCAB (e.g. Russell et al., 1983; Bassett and Seinfeld, 1983; Heisler and Friedlander, 1977; Bassett et al., 1981; Seigneur et al., 1985).

Wet and dry deposition of atmospheric constituents in the SOCAB are not well understood, even though Roberts (1975) estimated that nearly 50% of the sulfur oxides are removed at the ground within the Basin and Morgan and Liljestrand (1980) estimated that the dry deposition of pollutants may exceed wet deposition by an order of magnitude. Most theoretical formulations of deposition describe the flux to the surface as a product of an ambient concentration and a deposition velocity. These deposition velocities are functions of turbulent diffusion near the ground, molecular motions at the ground-air interface, and the reaction of the pollutant with the surface. McRae et al. (1982b) mathematically described the turbulent diffusion mechanisms and found that the deposition rates are extremely sensitive to atmospheric stability. They noted that there are no satisfactory theoretical treatments of mass transfer close to the surface and that field data on pollutant uptake by surfaces are inadequate. Dry deposition samples in the SOCAB have been collected on surrogate surfaces (as summarized in Shikiya et al., 1984), but these are not considered to be accurate estimates of dry deposition fluxes.

2.2.3 Receptor Measurements

Figure 2-1 shows the sampling sites which have been acquiring routine air quality monitoring data in the South Coast Air Basin. Though several of these sites have changed from time to time, the basic network has remained essentially the same since 1965. Ludwig et al. (1983) have examined the spatial distribution of this network with respect to its adequacy in

determining ozone standard violations. They found that as few as ten of the SCAQMD stations would provide an accurate estimate of the number of exceedances per site. The coverage of this network is such that coastal, inland, and valley areas are represented. All EPA siting criteria and shelter requirements are complied with at all sites.

Table 2-3 identifies the routine measurements which are made at existing sampling sites in the South Coast Air Basin. Carbon monoxide by non-dispersive infrared spectrophotometry, ozone by ultraviolet photometry, nitric oxide and nitrogen oxides by chemiluminescence, sulfur dioxide by pulsed fluorescence, total hydrocarbons by flame ionization detector, and total suspended particulate matter by standard HiVol samplers are measured at most sites. Gas concentrations of one-hour duration are acquired continuously and suspended particle samples of 24-hour duration are acquired on an every-sixth-day schedule. Mass, sulfate, nitrate, and lead measurements are made on most of the HiVol samples. Size-classified particulate matter in the 0 to 10 μm size range is currently being collected at 11 sites, as indicated in Table 2-3, using automatic mass flow controlled high volume samplers with Sierra-Anderson 321A size-selective inlets. This monitoring is being performed in anticipation of the promulgation of a new national ambient air quality standard for particulate matter (Federal Register, 1984) and to determine compliance with California's size-selective particulate matter standard. Mass, sulfate and nitrate measurements are currently being made on these samples.

Table 2-3 also shows the distribution of surface meteorological monitoring networks which acquire wind speed, wind direction, temperature, relative humidity, and insolation data. Goodin et al. (1979, 1980) have examined the adequacy of this network for replicating a known surface wind field and have found it adequate when the proper interpolation and adjustment schemes are used. The network is not adequate, however, for determining a three-dimensional wind field.

Ambient air quality data acquired from this network over many years show the following general features taken from the 1982 Summary of Air Quality (SCAQMD, 1983; Hoggan et al., 1983):

- Ozone. Coastal stations experience the lowest concentrations and the lowest number of standard exceedance cases. Concentrations increase sharply from the coastal to the inland valley portions of the Basin. The area with the highest ozone levels extends from the San Fernando Valley through the San Gabriel Valley and into the Riverside-San Bernardino area and adjacent mountains. In 1982, Azusa, Pico Rivera, Los Angeles, and Norco exhibited hourly ozone concentrations in excess of 0.35 ppm. The highest value of 1982 was 0.40 ppm which occurred at the downtown Los Angeles site between noon and 1 p.m. on September 2, 1982. Figures 2-6a, b, c, and d show long-term trends, monthly averages, and the diurnal pattern of ozone concentrations at Azusa which are typical of the patterns at most inland sites in the network. Highest ozone dosages tend to occur at elevated sites in the San Gabriel and San Bernardino Mountains. NO values are very low at these sites, and there is little opportunity for the O_3 which reaches them to be scavenged.
- Carbon Monoxide. More than half of the SOCAB stations are in compliance with the CO standard. The highest concentrations are observed during the